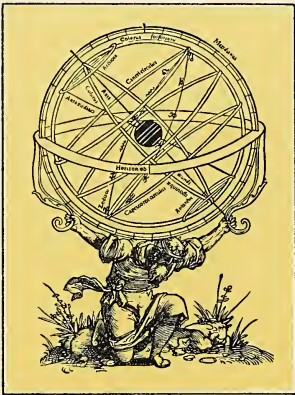


*The Dibner Library
of the History of
Science and Technology*

SMITHSONIAN INSTITUTION LIBRARIES



Magn.

PROSPECTUS
OF A
COURSE OF LECTURES
ON SOME OF THE PRACTICAL PARTS
OF THE
MATHEMATICS,

VIZ.

PART FIRST.
ASTRONOMY,
GEOGRAPHY,
NAVIGATION.



PART SECOND.
GUNNERY,
AND
FORTIFICATION.

BY JOHN PLAYFAIR,
PROFESSOR OF MATHEMATICS IN THE UNIVERSITY
OF EDINBURGH.

EDINBURGH:

1793.

1073880 27

1911-12-28 10:00

1073880 27

1911-12-28 10:00

1073880	27
1073880	27
1073880	27
1073880	27
1073880	27

1911-12-28 10:00

1073880 27

1073880 27

1073880 27

QA
11
P72
1793
RB
NMAH

PROSPECTUS
OF A
COURSE OF LECTURES, &c.

[*Edinburgh College, October 18. 1793.*]

A S T R O N O M Y.

I.

GENERAL view of the Phænomena of the
Heavens.—Apparent Motion of the fixed
Stars, of the Sun, Moon, Planets, Satellites of
the Planets, Comets.—To have a more ac-
curate knowledge of these, the Doctrines of
the Sphere must be explained.—Definitions.—

A

Poles.

Poles.—Primary Circles, *viz.* Equator, Parallels ; Hour Circles or Meridians, Ecliptic, Tropics.—Arches of the Equator measured by Degrees or by Hours.—Conversion of one of these measures into the other.

Secondary Circles, Horizon, Verticals, &c.—Latitude and Longitude—Right Ascension and Declination of the Stars.—Altitude, Azimuth of Stars.—Zenith of a Place ; Latitude of a Place defined.—Elevation of the Pole.

II.

Orthographical Projection of the Sphere.—Solution of various Problems concerning the Circles of the Sphere deduced from that Projection, *viz.* the Position of a Star in respect of the Equator being given, to find its Position in respect of the Ecliptic, *et vice versa*.—The Declination of a Star being given, and its Altitude above the Horizon of a place in a known Latitude, to find its Azimuth, and the time which it requires to come to the Meridian, or more generally, any three of these five Elements being given, to find the other two ; also the Latitude of a Place, and the Declination of a Star being given, to find the time of its stay above the Horizon.

III.

Of the Instruments required for determining the Position of the Heavenly Bodies, in respect

of the Circles of the Sphere.—1. Instruments for measuring Angles; Telescope, Astronomical Quadrant, HADLEY's Quadrant, Micrometer; Gnomon.—2. Instruments for measuring Time; Sun-dial, Clock, Transit Telescope.

IV.

Optical Illusions which affect Astronomical Observations.—1. Refraction of Light by the Atmosphere.—Law.—Table of Refractions for different Altitudes.—Vary with the Barometer and Thermometer. — 2. Parallax. — Depends on the distance of the Body observed, from the Earth, and its Elevation above the Horizon. — Theorems respecting the Parallax of the Stars.

V.

Astronomical Observations.—1. For distinguishing particular Stars or Constellations.—2. For finding the Meridian line, and the Latitude.—3. For the Regulation of Time, and finding the right Ascension of a Star.—4. For finding the Declination of a Star.—5. For determining the instant of a given Phenomenon, as of the Equinox, the Solstice, &c.—6. For determining the Apparent Magnitude of a Star, or the Angle subtended by its Diameter.—7. For marking the Phases, or the different appearances on the Disk of a Planet, Solar Spots, &c.

VI.

VI.

The Principles on which the real Motions of the Heavenly Bodies are to be deduced from the observation of their apparent Motions.—Facts enumerated on which this deduction is founded ; of three kinds, relating to the Motion in Longitude, the Motion in Latitude, and the apparent Magnitude of the Planets.—Hence are inferred the Motion of the Earth, the Immobility of the Sun, *and the true System of the World.*

VII.

The Earth's Motion particularly considered. Parallelism and Obliquity of its Axis.—Change of Seasons.—Elliptical Orbit.—Equal Areas described in equal Times.—From the unequal Velocity of the Earth, and from the Obliquity of the Ecliptic results an Inequality in the Length of the Solar Day.—Equation of Time.—Siderial and Solar Day.—Year, Siderial and Tropical.—Hence the Precession of the Equinoxes. Parallelism of the Earth's Axis not perfect ; —Slow Conical Motion.

VIII.

Farther consideration of the Earth's Orbit, and the Measure of Time.—Repler's Problem.—Astronomical Tables.—Equation of the Centre.—
Right

Right Ascension and Declination of the Sun.
Small variation in the Obliquity of the Ecliptic.—Astronomical principles of Chronology.—Calendar.

IX.

The Moon's Motion particularly considered.—Period; Lunation.—Mean Motion.—Irregularities; Annual Equation; Equation of the Centre, Evection, &c.—Moon's Parallax.—Lunar Tables.

X.

Relative Motions of the Sun and Moon.—Eclipses.—Calculation of Eclipses.—Lunar Periods.—Transit of the Moon over a Star.

XI.

Of the Orbits of the other Planets; primary and secondary.—Three General Laws.—1. Orbits Elliptical; 2. Areas uniformly described; 3. Squares of the Periods as the Cubes of the Distances.—Tables of the Planetary Motions.—Relative Motions.—Transits of Mercury and Venus over the Sun.—Dimensions of the Solar System.

XII.

Laws of the Motion of Comets.—Their Orbits Parabolic or Elliptical.—Return of Comets.
—Areas

—Areas uniformly described.—Affinity to the Planetary Motions.

XIII.

Distance of the fixed Stars.—Diameter of the Earth's Orbit subtends an exceedingly small Angle at that distance.—Limit to the Magnitude of this Angle.—Aberration of the fixed Stars explained.—Varieties among the fixed Stars.—Milky Way.—Nebulæ.—Double and triple Stars.—New Stars.—Catalogues.

XIV.

A general view of the Physical Causes of the Motions described above.—Remarks on the Affinity between the Earth and the Planets.

G E O G R A-

G E O G R A P H Y.

I N T R O D U C T I O N.

The natural Divisions of the Earth, are either marked out by Astronomical Phænomena, or by the Properties of Terrestrial Bodies.—Astronomical and Physical Geography.—Remarks on the History of each.

A S T R O N O M I C A L G E O G R A P H Y.

I.

Magnitude and Figure of the Earth.—Measurement of Degrees of the Meridian in different Latitudes.—Increase from the Equator to the Poles.—Spheroidal Figure of the Earth, compressed at the Poles.—Proportion of the Earth's Axis to the Diameter of the Equator.—Mean Degree.—Circumference of the Earth.—Superficies, in square Degrees.—Geographical Mile ; its Proportion to the common Itinerary Measures.—Of the Degree of Accuracy at present obtained in the determination of the Figure of the Earth.

II.

II.

Division of the Earth's Surface by Parallels of Latitude.—To find the Latitude of any Place.—Of the Division of the Earth's Surface into Zones; Proportion of these Zones to one another.—Division by the falling of the Shadows of upright Objects: By the different lengths of the Day and Night.—Ancient idea of Climates.—Theorems for finding the rising and setting of the Sun and Stars.—Curious Rule of the Indian Astronomers for that purpose.

III.

Division of the Earth's Surface by Circles of Longitude.—Methods of finding the Longitude of a Place.—Why this Problem is more difficult than that of finding the Latitude.—1. Of the Method by Eclipses of the Moon, or of the Satellites of Jupiter.—2. By the illumination of certain spots on the Disk of the Moon.—3. By Time-keepers.—4. By the Transit of the Moon over the Meridian.—5. By the Moon's Distance from a Star.—6. The Moon's Altitude.—7. An Eclipse of the Sun. 8. The Transit of the Moon over a Star.—In practice, the Difference of Longitude is sometimes

times inferred from the Itinerary Distance, when the Latitudes are known.

IV.

Representation of the Earth's Surface on that of the Artificial Globe.—Uses of the Globe.—Resolution of Problems respecting the Doctrine of the Sphere.

V.

Representation of the Earth's Surface on a Plane.—Maps.—The simplest is the Plain Chart.—Principles of the Stereographic Projection.—Of the Globular or DE LA HIRE'S.—Of the Conical Projection invented by MURDOCH.—Of the Projection used in the Maps of SENEX and D'ANVILLE, &c.—General Remarks on the Construction and Use of Maps.

PHYSICAL GEOGRAPHY.

I.

Division of the Earth, according to the Properties of the Substances which compose it.—Most general division into Solid and Fluid.—Fluid into Water and Air.—The order in which they must be considered is Water, Earth, Air.—Of the Ocean.—Surface every where perpendicular to the direction of Gravity.—Extent.

B

Divisions.

Divisions.—Depth.—Saltnefs.—Productions of the Sea.—General Motion.—Phœnomena of the Tides.—Cause.—The part of the Moon's Attraction employed in producing them.—Spring Tides.—Oppofite Tides.—How far Obfervation and Theory agree.—Effect of Shores, Straits, &c.—Tide inconfiderable in Mediterranean Seas.—Particular Motions of the Sea.—Currents.—Gulph Stream, &c.—Whirlpools.

II.

Of the Land. Natural Divifions arifing from the Properties of the more Solid Parts.—Thefe are either Stratified or Unftratified.—1^{ft}, Stratified divided into Primary and Secondary.—Characters of each.—2^d, Unftratified divided into Dykes, Maffes and Veins.—Materials of each.—Dr HUTTON's Theory.—Sketch of the Geographic Hiftory of Metallic Veins and Ores.

III.

Natural Divifions of the Earth from the Inequalities of its Surface.—Mountains.—General Facts concerning the Structure of Mountains.—Height of Mountains.—Great Chains.—Alps.—Ourals.—Altaic Mountains.—Caucafus.—Cordilleras.—Volcanic Mountains.—Vefuvius, Etna, &c.

IV.

IV.

Natural Divisions of the Earth connected with the Atmosphere.—Constituent Parts of the Atmosphere.—Elasticity of Air.—Law of the Decrease of Density on ascending into the Atmosphere.—Decrease of Temperature.—Circle of Perpetual Congelation.—Measurement of Heights by the Barometer.—Evaporation.—Hygrometer.—Atmosphere considered with respect to the œconomy of Animals and Vegetables.

V.

Atmosphere considered as forming a communication between the Sea and the Dry-land.—Evaporation.—Dr HUTTON's Theory of the Formation of Rain.—Average Quantity of Rain that falls annually.—Connection of Rain with the Rise and Fall of the Barometer.—Periodical Rains.—Countries where there is no Rain.—Deserts.

VI.

Origin of Rivers.—Springs.—Lakes.—Salt and Fresh Lakes.—Supply from the Rain.—Sufficiency of that supply.—Bason, or tract drained by a River.—Dr HALLEY's Computation.—Laws of the Motion of Rivers.—Velocity.—Formation of their Channels.—Bendings.—

ings.—Accumulation of Earth at the Mouths of great Rivers.—Rivers subject to Periodical Inundations.—Nile.—Ganges, &c.

VII.

Natural Divisions of the Earth arising from the distribution of Heat and Cold on its Surface.—Laws of the communication of Heat, in Solids,—in Fluids.—Thermometer.—Temperature.—Climate.—Action of the Sun's Rays, the Primary Cause.—Communication of Heat by the Atmosphere, the Secondary Cause.—General Operations of these Causes exemplified in the Climate of the Torrid Zone,—of the Temperate,—the Frigid.—Modification by Local Causes.—By Elevation,—Culture,—Evaporation, &c.—The Temperature of the Earth on the whole permanent.—Not subject to the constant diminution supposed by M. DE BUFFON.

VIII.

Unequal distribution of Heat in the Atmosphere, the Cause of Winds.—Winds considered according to the different regions where they prevail.—Constant, or Trade Winds.—Periodical Winds, or Monsoons.—Irregular Winds.—Hurricanes.—

ricanes.—Whirlwinds, &c.—Effect on the Barometer.

IX.

Divisions of the Earth formed by the Phenomena of Magnetism.—Magnetical Poles.—Equator.—Lines of no Variation, &c.—Position of the Magnetical Poles inferred from the Variation, and *vice versa*.—Tolerable Agreement of Theory and Observation.—Magnetical Poles change their Situation.—Law not ascertained.

X.

Illustration of the Principles explained, under the preceding Heads, by a general Survey of the Old and New Continents.—Directions for studying Geography in Detail.

NAVIGA-

N A V I G A T I O N.

I.

Navigation a Branch of Geography.—General Problem, in the Solution of which Navigation consists.—Instruments for ascertaining the necessary Data, *viz.* The Course and Distance.—Log.—Mariners Compass.—Rhumb-line or Loxodromic.—Variation of the Compass, and method of finding it.—Ship's Reckoning.

II.

The same Data ascertained by Astronomical Observation.—Of the Latitude.—Found by Observation of the greatest Altitude of the Sun or a Star.—By equal Altitudes.—Different Cases.—Correction for Refraction and the Height of the Eye.—Singular Advantages of HADLEY'S Quadrant at Sea.

III.

Of finding the Longitude at Sea.—Method by Time-keepers.—Method by the Moon's distance from a Star.—Rules for making the Observation.—For calculating the Longitude.—Nautical Almanack.—Advantage of combining these two Methods together.

IV.

IV.

Navigation requires, besides the above, the construction of Charts.—Plain Chart, its construction and use; its imperfections.—MERCATOR'S Chart—a series of plain Charts, in which the Scale varies so as to preserve the Degree of Longitude always of the same Length.—Construction and Use of this Chart.—Marine Surveying.

V.

Plain Sailing, or Sailing by the Plain Chart—Reduced to the solution of right-angled plain Triangles.—Traverse Table.—Manner of Working.—Corrections of the results by the Latitude observed.

VI.

Globular Sailing.—Rules of it derived from Spherical Trigonometry, or from the Orthographic Projection explained above, Astron. § II.—Construction given by MERCATOR'S Chart.—Of the Mean to be taken when the Data from the Ship's reckoning, and from Astronomical observation disagree.—Of the correction to be made on account of the Spherical figure of the Earth.—Conclusion.

P A R T

P A R T II.

G U N N E R Y.

I.

Theory of Projectiles.—Perpendicular Descent and Ascent of Bodies.—A Body obliquely projected *in vacuo* describes a Parabola.—Properties of that Curve.—Problems in Gunnery resolved by it.—Definitions.—Impetus, Range, &c.—Impetus and Range given to find the Direction.—Range and Direction to find the Impetus.—Greatest Range.—Horizontal Range greatest when the elevation is 45° .

II.

Deviations from the preceding Theory, produced by the resistance of the Air.—Become greater as the Motion is swifter.—Difficulty of ascertaining them exactly.—Conclusions from Theory.—From Experiment.—Effect of the resistance calculated when the Motion is nearly rectilineal.—Greatest horizontal Range in the Air, is with an Elevation less than 45° .

III.

III.

Of Gun-powder.—Its Composition.—Elastic fluid disengaged in the combustion of it.—Quantity and Heat of this Fluid.—Its Force calculated.—Manner of its communicating Motion.—Greatest Velocity which it can communicate.—Of the Velocity with which a Ball issues from the mouth of the Piece.—Experiments with the Ballistic Pendulum.

IV.

Description of different kinds of Ordnance.—Ship Guns.—Battering Cannon.—Field Pieces.—Mortars, &c.—Experiments on the proper length of Guns.—Quantity of Powder.—Its force increased by the heating of the Gun.—Distance to which Shot may be thrown.—Point-blanc Firing.—Penetration of Shot into Earth, Timber, &c.—Deviation of Balls from the vertical Plane.—Remedies proposed.—Rifled Guns, &c.

FORTIFICATION.

I.

Nature of the Weapons used determines the manner of Defence.—Principles established for determining the Figure of a Fortified Place.—Walls low.—Angles alternately salient and re-entering.—Works flanking one another.—Geometrical Plan of a regular Fortification of any number of Sides.—Construction on Paper.—Explanation of Terms.—Solution of some Geometrical Problems, useful in these Constructions.—Of the latitude that the Plan admits of.—Construction of the Profiles.

II.

Of laying down the Plan on the Ground.—Instruments to be used. Actual Construction of the Works.—Practical Rules.—Slop of Earth-walls and Ditches.—Strength of Stone-walls.—Sluices—Bridges—Casemats.—Digression concerning Military Surveys.

III.

Fortification of irregular Places. — 1. When the Ground is flat, but irregular in its Figure.—2. When a Hill is to be fortified.—3. When the Place is on the Banks of a River,

River, or on the Sea-shore.—Of temporary Fortifications.—Intrenched Camps.—Lines.—Posts, &c.

IV.

Attack of fortified Places.—General Maxims.—Circumvallation.—Approaches constructed on Paper.—Geometrical properties of lines so drawn.—The rapidity with which they advance decreases in Geometrical Progression.—Method of transferring the Approaches to the Ground.—Of carrying on the Work.—Parallels.—Batteries.—Mines.—Charge necessary for a Mine of a given depth.—Figure of the Excavation investigated on different suppositions.—Rule not general, that the width is twice the depth.

Note. The divisions in this Prospectus do not refer to the Number of the Lectures, but of the Heads under which the Lectures are arranged.

